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Bombarding an atom with ion-beams, orbital electrons of K-, L-, and M-shells are ionized by the Coulomb interaction with the projectiles and characteristic x-rays are produced corresponding to their vacant shells. When we measure the characteristic x-rays with very accuracy, in addition to components of main radiative transitions, we observe fine structures or satellite lines on the x-ray spectrum. Intensity and x-ray energy of the radiative transition from valence orbits change for a chemical state of target atom. Many satellite lines are produced by multiple inner shell ionizations. Therefore, precise measurement of x-rays is requested to study chemical effects on ionized atoms and multiple ionization mechanism in ion-atom collisions. However, in PIXE (Particle Induced X-ray Emission) analysis, we usually use a semiconductor detector Si (Li) of an energy resolution (~150 eV) which is insufficient to investigate the fine structures on characteristic x-ray spectrum are insufficiently investigated. On the other hand, x-ray crystal spectrometer has a high energy resolution of a few eV and it is useful to the above study.

X-spectra are usually obtained by varying the Bragg's angle between the axis of a curved crystal (or a flat crystal) and the incident direction of x rays, and by detecting x rays with a proportional counter. In the case that the spot and intensity of beam are not enough stable, x-ray spectrum can not be precisely obtained by this method. For an example, this method should be carefully used to cyclotron beam. A new type of proportional counter which can measure detected positions of x rays, are commercially available at present. Combining this position sensitive proportional counter with a flat crystal, x-ray spectra can be obtained without scanning a proportional counter, in contrast with the above method. The principle of this method[1)] is illustrated in Figure 1 of Ref. 1. By changing the angle between the beam axis and the reflection plane of x rays , we can also measure a degree of deflection of x rays. We fixed such an x-ray spectrometer with an EDDT crystal at the 33-beam course of cyclotron and radioisotope center, Tohoku university.

Figure 1 shows the x-ray spectrum from a gold target bombarded with 3 MeV protons. The energy resolution of spectrometer is estimated by about 9 eV for 2.123 keV. As seen in this figure, a continuous background spreads out under the Au M_α- and M_β- lines. This background is a very serious problem to the sensitivity of spectrometer. We consider that ,scattered by walls of a vacuum chamber, M-x rays produced from the target permeate the chamber. We put a solar slit between a vacuum chamber of spectrometer and a target one. The scattered M-x rays may be reduced through this solar slit.

Figure 2 shows the Au M x-ray spectrum obtained by the use of the solar slit with a clearance width of 0.78 mm, where x rays are observed from 200 ch to 500 ch because of a finite size (45 mm) of crystal. We can see a much improvement in background in this figure where the background is reduced to 1/100 of the previous one and the Lorentian tails of M_α - and M_β - lines are recognized.

References

1) Ishii K. et al., Vacuum 39(1989)97.

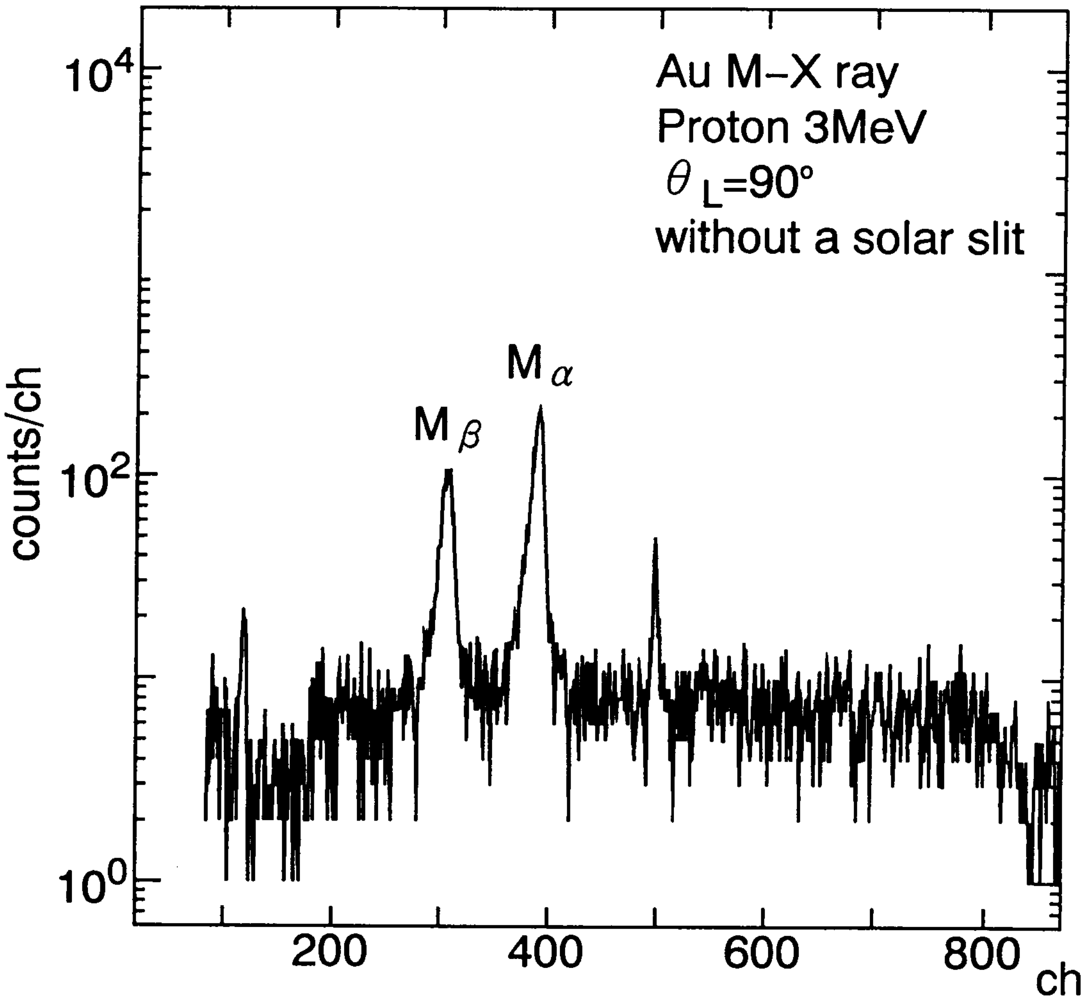

Fig. 1. Au M x-ray spectrum obtained by a crystal spectrometer without a solar slit.

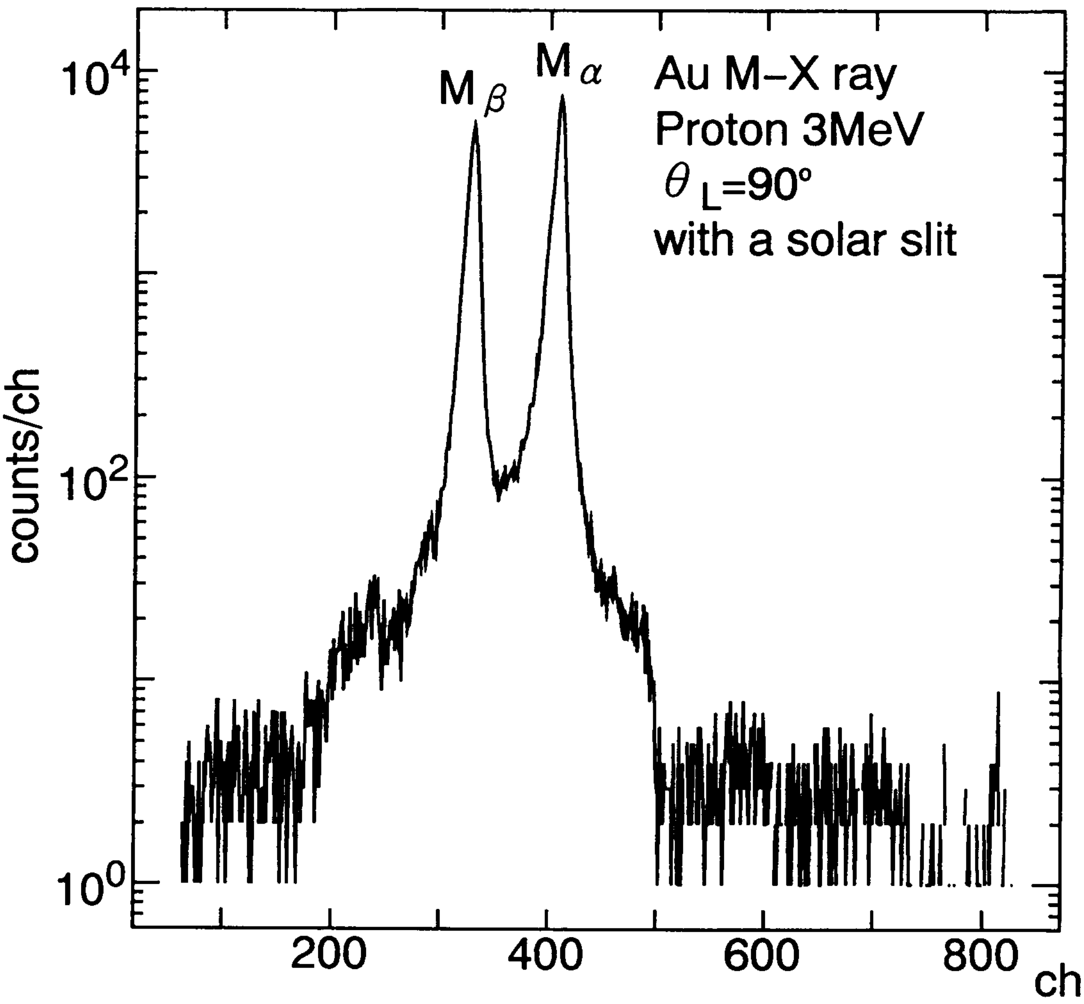

Fig. 2. Same as Fig. 1 except for with a solar slit.